WHAT IS CLAIMED IS:

1. A composition comprising:

(a) a non-natural molecular scaffold comprising:

(i) a core particle, and

(ii) an organizer comprising at least one first attachment site, wherein said organizer is connected to said core particle by at least one covalent bond, and wherein said core particle is a virus-like particle comprising recombinant proteins, or fragments thereof, of a bacteriophage;

(b) an antigen or antigenic determinant with at least one second attachment site, said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

2. The composition of claim 1, wherein said association is by way of at least one covalent bond.

3. The composition of claim 1, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

4. The composition of claim 1, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

5. The composition of claim 1, wherein said bacteriophage is a RNA-phage.

6. The composition of claim 5, wherein said RNA-phage is selected from the group consisting of:

a) bacteriophage Qβ;

b) bacteriophage R17;

c) bacteriophage fr;

d) bacteriophage GA;
e) bacteriophage SP;
f) bacteriophage MS2;
g) bacteriophage M11;
h) bacteriophage MX1;
i) bacteriophage NL95;
k) bacteriophage f2; and
l) bacteriophage PP7.

7. The composition of claim 5, wherein said recombinant proteins comprise coat proteins having an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:159;
b) the amino acid sequence of SEQ ID NO:160;
c) the amino acid sequence of SEQ ID NO:161;
d) the amino acid sequence of SEQ ID NO:162;
e) the amino acid sequence of SEQ ID NO:163;
f) the amino acid sequence of SEQ ID NO:164;
g) the amino acid sequence of SEQ ID NO:165;
h) the amino acid sequence of SEQ ID NO:166;
i) the amino acid sequence of SEQ ID NO:167;
j) the amino acid sequence of SEQ ID NO:215;
k) the amino acid sequence of SEQ ID NO: 253;
l) the amino acid sequence of SEQ ID NO: 217 and mutants thereof; and
m) the amino acid sequence of SEQ ID NO: 254.

8. The composition of claim 5, wherein said recombinant proteins comprise mutant coat proteins.

9. The composition of claim 8, wherein said mutant coat proteins have been modified by removal of at least one lysine residue by way of substitution, or by addition of at least one lysine residue by way of substitution.

10. The composition of claim 8, wherein said mutant coat proteins have been modified by deletion of at least one lysine residue, or by addition of at least one lysine residue by way of insertion.

11. The composition of claim 1, wherein said bacteriophage is bacteriophage Qβ.

12. The composition of claim 1, wherein said bacteriophage is bacteriophage fr.

13. The composition of claim 11, wherein said recombinant proteins comprise coat proteins having an amino acid sequence of SEQ ID NO:159, or a mixture of coat proteins having amino acid sequences of SEQ ID NO:159 and of SEQ ID NO: 217 or mutants of SEQ ID NO: 217.

14. The composition of claim 1, wherein said core particle is a virus-like particle of bacteriophage Qβ essentially consisting of coat proteins having an amino acid sequence of SEQ ID NO:159, or essentially consisting of a mixture of coat proteins having amino acid sequences of SEQ ID NO: 217, or mutants thereof, and of SEQ ID NO:159.

15. The composition of claim 11, wherein said recombinant proteins comprise mutant Qβ coat proteins.

16. The composition of claim 15, wherein said mutant Qβ coat proteins have been modified by removal of at least one lysine residue by way of substitution, or by addition of at least one lysine residue by way of substitution.

17. The composition of claim 15, wherein said mutant coat proteins have been modified by deletion of at least one lysine residue, or by addition of at least one lysine residue by way of insertion.

18. The composition of claim 15, wherein said mutant Qβ coat proteins comprise proteins having an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:255;

b) the amino acid sequence of SEQ ID NO:256;

c) the amino acid sequence of SEQ ID NO:257;

d) the amino acid sequence of SEQ ID NO:258; and

e) the amino acid sequence of SEQ ID NO:259.

19. The composition of claim 1, wherein said core particle is a virus-like particle of bacteriophage Qβ essentially consisting of mutant Qβ coat proteins having an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:255;

b) the amino acid sequence of SEQ ID NO:256;

c) the amino acid sequence of SEQ ID NO:257;

d) the amino acid sequence of SEQ ID NO:258;

e) the amino acid sequence of SEQ ID NO:259; and

f) a mixture of either a)-e) and the corresponding A1 protein.

20. The composition of claim 11, wherein said organizer is an integral part of said bacteriophage Qβ or said bacteriophage fr.

21. The composition of claim 1, wherein said core particle is a virus-like particle composed of recombinant proteins of a bacteriophage.

22. The composition of claim 1, wherein said first and/or said second attachment sites comprise:

(a) an antigen and an antibody or antibody fragment thereto;

(b) biotin and avidin;

(c) strepavidin and biotin;

(d) a receptor and its ligand;

(e) a ligand-binding protein and its ligand;

(f) interacting leucine zipper polypeptides;

(g) an amino group and a chemical group reactive thereto;

(h) a carboxyl group and a chemical group reactive thereto;

(i) a sulfhydryl group and a chemical group reactive thereto; or

(j) a combination thereof.

23. The composition of claim 1, wherein said first attachment site is an amino group and said second attachment site is a sulfhydryl group.

24. The composition of claim 1, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

25. The composition of claim 1, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

26. The composition of claim 25, wherein said first attachment site is an amino group and said second attachment site is a sulfhydryl group.

27. The composition of claim 25, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

28. The composition of claim 25, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

29. The composition of claim 25, wherein said composition comprises an amino acid linker.

30. The composition of claim 29, wherein said amino acid linker is bound to said antigen or said antigenic determinant by way of at least one covalent bond.

31. The composition of claim 29, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

32. The composition of claim 31, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

33. The composition of claim 31, wherein said amino acid linker is selected from the group consisting of:

(a) CGG

(b) N-terminal gamma 1-linker;

(c) N-terminal gamma 3-linker;

(d) Ig hinge regions;

(e) N-terminal glycine linkers;

(f) $(G)_kC(G)_n$ with n=0-12 and k=0-5;

(g) N-terminal glycine-serine linkers

(h) $(G)_kC(G)_m(S)_l(GGGGS)_n$ with n=0-3, k=0-5, m=0-10, l=0-2;

(i) GGC

(k) GGC-NH2

(l) C-terminal gamma 1-linker

(m) C-terminal gamma 3-linker

(n) C-terminal glycine linkers

(o) $(G)_nC(G)_k$ with n=0-12 and k=0-5;

(p) C-terminal glycine-serine linkers

(q) $(G)_m(S)_l(GGGGS)_n(G)_oC(G)_k$ with n=0-3, k=0-5, m=0-10, l=0-2, and o=0-8.

34. The composition of claim 1, wherein said antigen or said antigenic determinant is a self antigen or a fragment thereof, or an anti-idiotypic antibody or an anti-idiotypic antibody fragment.

35. The composition of claim 34, wherein said self antigen is a protein, a peptide or fragments thereof, selected from the group consisting of:

a) a lymphotoxin;

b) a lymphotoxin receptor;

c) RANKL;

d) VEGF;

e) VEGFR;

f) Interleukin 5;

g) Interleukin 17;

h) Interleukin 13;

i) Angiotensin;

k) CCL21;

l) CXCL12;

m) SDF-1;

n) MCP-1;

o) Endoglin;

p) Resistin;

q) GHRH;

r) LHRH;

s) TRH;

t) MIF;

u) Eotaxin;

v) Bradykinin;

w) BLC;

x) Tumor Necrosis Factor α (TNFα);

y) amyloid beta peptide ($A\beta_{1-42}$); and

z) a human IgE.

36. The composition of claim 34, wherein said self antigen is an angiotensin peptide or a fragment thereof.

37. The composition of claim 36, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

38. The composition of claim 36, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

39. The composition of claim 36, wherein said composition comprises an amino acid linker.

40. The composition of 39, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

41. The composition of claim 40, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

42. The composition of claim 36, wherein said angiotensin peptide with said second attachment site has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of CGGDRVYIHPF;
b) the amino acid sequence of CGGDRVYIHPFHL;
c) the amino acid sequence of DRVYIHPFHLGGC; and
d) the amino acid sequence of CDRVYIHPFHL.

43. The composition of claim 34, wherein said self antigen is a human VEGFR-II peptide or a fragment thereof.

44. The composition of claim 43, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

45. The composition of claim 43, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

46. The composition of claim 43, wherein said composition comprises an amino acid linker.

47. The composition of claim 46, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

48. The composition of claim 47, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

49. The composition of claim 43, wherein said VEGFR-II peptide with said second attachment site has an amino acid sequence of CTARTELNVGIDFNWEYPSSKHQHKK.

50. The composition of claim 34, wherein said self antigen is tumor necrosis factor α (TNF-α), fragments thereof or peptides of TNF-α.

51. The composition of claim 50, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

52. The composition of claim 50, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

53. The composition of claim 50, wherein said composition comprises an amino acid linker.

54. The composition of 53, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

55. The composition of claim 54, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

56. The composition of claim 50, wherein said tumor necrosis factor α (TNF-α), fragments thereof or peptides of TNF-α_with said second attachment site has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of CSSRTPSDKPVAHVVANPQAEGQ;

b) the amino acid sequence of SSRTPSDKPVAHVVANPQAEGQGGC; and

c) the amino acid sequence of CGGQLQWLNRRANA.

57. The composition of claim 34, wherein said self antigen is resistin or a fragment thereof.

58. The composition of claim 57, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

59. The composition of claim 57, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

60. The composition of claim 57, wherein said composition comprises an amino acid linker.

61. The composition of 60, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

62. The composition of claim 61, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

63. The composition of claim 57, wherein said resistin protein, or fragment thereof, with said second attachment site has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:325;
b) the amino acid sequence of SEQ ID NO:326; and
c) the amino acid sequence of SEQ ID NO:327.

64. The composition of claim 34, wherein said self antigen is a lymphotoxin or a fragment thereof selected from the group consisiting of:

a) lymphotoxin α (LTα)
b) lymphotoxin β (LTβ)
c) a mixture or combination of LTα and LTβ.

65. The composition of claim 64, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

66. The composition of claim 64, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

67. The composition of claim 64, wherein said composition comprises an amino acid linker.

68. The composition of 67, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

69. The composition of claim 68, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

70. The composition of claim 64, wherein self antigen is lymphotoxin β, or a fragment thereof, and wherein said lymphotoxin β with said second attachment site has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:346; and

b) the amino acid sequence of SEQ ID NO:347.

71. The composition of claim 34, wherein said self antigen is human-MIF or a fragment thereof.

72. The composition of claim 71, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

73. The composition of claim 71, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

74. The composition of claim 71, wherein said composition comprises an amino acid linker.

75. The composition of claim 74, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

76. The composition of claim 75, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

77. The composition of claim 71, wherein said human-MIF protein, or fragment thereof, with said second attachment site has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:310;
b) the amino acid sequence of SEQ ID NO:311;
c) the amino acid sequence of SEQ ID NO:312;
d) the amino acid sequence of SEQ ID NO:313;
e) the amino acid sequence of SEQ ID NO:314; and
f) the amino acid sequence of SEQ ID NO:315.

78. The composition of claim 34, wherein said self antigen is human-RANKL or a fragment thereof.

79. The composition of claim 34, wherein said self antigen is a extracellular part of human-RANKL or a fragment thereof.

80. The composition of claim 78 or claim 79, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

81. The composition of claim 78 or claim 79, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

82. The composition of claim 78 or claim 79, wherein said composition comprises an amino acid linker.

83. The composition of 82, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

84. The composition of claim 83, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

85. The composition of claim 78, wherein said human-RANKL, or fragment thereof, with said second attachment site comprises an amino acid sequence of SEQ ID NO:320 or fragments thereof.

86. The composition of claim 39, 46, 53, 60, 67, 74 or 82, wherein said amino acid linker is selected from the group consisting of:

(a) CGG

(b) N-terminal gamma 1-linker;

(c) N-terminal gamma 3-linker;

(d) Ig hinge regions;

(e) N-terminal glycine linkers;

(f) $(G)_kC(G)_n$ with n=0-12 and k=0-5;

(g) N-terminal glycine-serine linkers

(h) $(G)_kC(G)_m(S)_l(GGGGS)_n$ with n=0-3, k=0-5, m=0-10, l=0-2;

(i) GGC

(k) GGC-NH2

(l) C-terminal gamma 1-linker

(m) C-terminal gamma 3-linker

(n) C-terminal glycine linkers

(o) $(G)_nC(G)_k$ with n=0-12 and k=0-5;

(p) C-terminal glycine-serine linkers

(q) $(G)_m(S)_l(GGGGS)_n(G)_oC(G)_k$ with n=0-3, k=0-5, m=0-10, l=0-2, and o=0-8.

87. A composition comprising:

(a) a non-natural molecular scaffold comprising:

(i) a core particle selected from the group consisting of:

(1) a core particle of non-natural origin; and

(2) a core particle of natural origin; and

(ii) an organizer comprising at least one first attachment site,

wherein said organizer is connected to said core particle by at least one covalent bond,;

(b) an antigen or antigenic determinant with at least one second attachment site,

wherein said antigen or antigenic determinant is an anti-idiotypic antibody or an anti-idiotypic antibody fragment, and wherein said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

88. The composition of claim 87, wherein said association is by way of at least one covalent bond.

89. The composition of claim 87, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

90. The composition of claim 87, wherein said core particle is selected from the group consisting of:

i) a virus;
ii) a virus-like particle;
iii) a bacteriophage;
iv) a bacterial pilus;
v) a viral capsid particle; and
vi) a recombinant form of (i), (ii), (iii), (iv) or (v).

91. The composition of claim 87, wherein said core particle is selected from the group consisting of:

i) a virus-like particle;
ii) a bacterial pilus; and
iii) a virus-like particle of a RNA-phage.

92. The composition of claim 91, wherein said virus-like particle comprising recombinant proteins, or fragments thereof, being selected from the group consisting of:

(a) recombinant proteins of Hepatitis B virus;
(b) recombinant proteins of measles virus;
(c) recombinant proteins of Sindbis virus;
(d) recombinant proteins of Rotavirus;
(e) recombinant proteins of Foot-and-Mouth-Disease virus;
(f) recombinant proteins of Retrovirus;

(g) recombinant proteins of Norwalk virus;
(h) recombinant proteins of Alphavirus;
(i) recombinant proteins of human Papilloma virus;
(j) recombinant proteins of Polyoma virus;
(k) recombinant proteins of bacteriophages; and
(l) recombinant proteins of RNA-phages;
(m) recombinant proteins of Qß-phage;
(n) recombinant proteins of GA-phage
(o) recombinant proteins of fr-phage; and
(p) recombinant proteins of Ty.

93. The composition of claim 91, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage.

94. The composition of claim claim 91, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage being selected from the group consisting of:

a) bacteriophage Qβ;
b) bacteriophage R17;
c) bacteriophage fr;
d) bacteriophage GA;
e) bacteriophage SP;
f) bacteriophage MS2;
g) bacteriophage M11;
h) bacteriophage MX1;
i) bacteriophage NL95;
k) bacteriophage f2; and
l) bacteriophage PP7.

95. The composition of claim 105, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of bacteriophage Qβ or bacteriophage fr.

96. The composition of claim 87, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

97. The composition of claim 96, wherein said composition comprises an amino acid linker.

98. The composition of claim 97, wherein said amino acid linker comprises, or alternatively consists of, said second attachment site.

99. The composition of claim 98, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

100. A composition comprising:

(a) a non-natural molecular scaffold comprising:

(i) a core particle selected from the group consisting of:

(1) a core particle of non-natural origin; and

(2) a core particle of natural origin; and

(ii) an organizer comprising at least one first attachment site, wherein said organizer is connected to said core particle by at least one covalent bond,;

(b) an antigen or antigenic determinant with at least one second attachment site,

wherein said antigen or antigenic determinant is a self antigen or a fragment thereof, and wherein said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

101. The composition of claim 100, wherein said association is by way of at least one covalent bond.

102. The composition of claim 100, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

103. The composition of claim 100, wherein said core particle is selected from the group consisting of:

i) a virus;
ii) a virus-like particle;
iii) a bacteriophage;
iv) a bacterial pilus;
v) a viral capsid particle; and
vi) a recombinant form of (i), (ii), (iii), (iv) or (v).

104. The composition of claim 103, wherein said organizer is a polypeptide or residue thereof and said second attachment site is a polypeptide or residue thereof.

105. The composition of claim 100 or claim 103, wherein said core particle is a virus-like particle.

106. The composition of claim 105, wherein said virus-like particle is a dimer or multimer of a polypeptide comprising amino acids 1-147 of SEQ ID NO:158.

107. The composition of claim 106, wherein said virus-like particle is a dimer or multimer of a polypeptide comprising amino acids 1-152 of SEQ ID NO:158.

108. The composition of claim 105, wherein said first attachment site comprises or is an amino group and said second attachment site comprises or is a sulfhydryl group.

109. The composition of claim 105, wherein said virus-like particle is a Hepatitis B virus capsid protein.

110. The composition of claim 109, wherein said first attachment site comprises or is a lysine residue and said second attachment site comprises or is a cysteine residue.

111. The composition of claim 110, wherein one or more cysteine residues of said Hepatitis B virus capsid protein have been either deleted or substituted with another amino acid residue.

112. The composition of claim 110, wherein said Hepatitis B virus capsid protein comprises an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:89;
b) the amino acid sequence of SEQ ID NO:90;

c) the amino acid sequence of SEQ ID NO:93;
d) the amino acid sequence of SEQ ID NO:98;
e) the amino acid sequence of SEQ ID NO:99;
f) the amino acid sequence of SEQ ID NO:102;
g) the amino acid sequence of SEQ ID NO:104;
h) the amino acid sequence of SEQ ID NO:105;
i) the amino acid sequence of SEQ ID NO:106;
j) the amino acid sequence of SEQ ID NO:119;
k) the amino acid sequence of SEQ ID NO:120;
l) the amino acid sequence of SEQ ID NO:123;
m) the amino acid sequence of SEQ ID NO:125;
n) the amino acid sequence of SEQ ID NO:131;
o) the amino acid sequence of SEQ ID NO:132;
p) the amino acid sequence of SEQ ID NO:134;
q) the amino acid sequence of SEQ ID NO:157; and
r) the amino acid sequence of SEQ ID NO:158.

113. The composition of claim 112, wherein one or more cysteine residues of said Hepatitis B virus capsid protein have been either deleted or substituted with another amino acid residue.

114. The composition of claim 113, wherein the cysteine residues corresponding to amino acids 48 and 107 in SEQ ID NO:134 have been either deleted or substituted with another amino acid residue.

115. The composition of claim 112, wherein one or more lysine residue of said Hepatitis B virus capsid protein have been either deleted or substituted with another amino acid residue.

116. The composition of claim 100, wherein said core particle is a bacterial pilus.

117. The composition of claim 116, wherein said bacterial pilus is a Type-1 pilus of *Escherichia coli*.

118. The composition of claim 117, wherein pilin subunits of said Type-1 pilus comprises the amino acid sequence shown in SEQ ID NO:146.

119. The composition of claim 100, wherein said core particle comprises a bacterial pilin polypeptide.

120. The composition of claim 119, wherein said bacterial pilin polypeptide comprises the amino acid sequence shown in SEQ ID NO:146.

121. The composition of claim 105, wherein said virus-like particle comprising recombinant proteins, or fragments thereof, being selected from the group consisting of:

(a) recombinant proteins of Hepatitis B virus;
(b) recombinant proteins of measles virus;
(c) recombinant proteins of Sindbis virus;
(d) recombinant proteins of Rotavirus;
(e) recombinant proteins of Foot-and-Mouth-Disease virus;
(f) recombinant proteins of Retrovirus;
(g) recombinant proteins of Norwalk virus;
(h) recombinant proteins of Alphavirus;
(i) recombinant proteins of human Papilloma virus;
(j) recombinant proteins of Polyoma virus;
(k) recombinant proteins of bacteriophages; and
(l) recombinant proteins of RNA-phages;
(m) recombinant proteins of Qß-phage;
(n) recombinant proteins of GA-phage
(o) recombinant proteins of fr-phage; and
(p) recombinant proteins of Ty.

122. The composition of claim 105, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage.

123. The composition of claim 105, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage being selected from the group consisting of:

a) bacteriophage Qβ;
b) bacteriophage R17;
c) bacteriophage fr;

d) bacteriophage GA;
e) bacteriophage SP;
f) bacteriophage MS2;
g) bacteriophage M11;
h) bacteriophage MX1;
i) bacteriophage NL95;
k) bacteriophage f2; and
l) bacteriophage PP7.

124. The composition of claim 105, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of bacteriophage Qβ or bacteriophage fr.

125. The composition of claim 100, wherein said core particle is selected from the group consisting of:

i) a virus-like particle;
ii) a bacterial pilus; and
iii) a virus-like particle of a RNA-phage.

126. The composition of claim 105, 109, 112, 116, 122, 123, or 124, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

127. The composition of claim 126, wherein said composition comprises an amino acid linker.

128. The composition of claim 127, wherein said amino acid linker is bound to said antigen or said antigenic determinant by way of at least one covalent bond.

129. The composition of claim 128, wherein said covalent bond is a peptide bond.

130. The composition of 127, wherein said amino acid linker comprises, or alternatively consist of, said second attachment site.

131. The composition of claim 130, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

132. The composition of claim 130, wherein said amino acid linker is selected from the group consisting of:

(a) CGG

(b) N-terminal gamma 1-linker;

(c) N-terminal gamma 3-linker;

(d) Ig hinge regions;

(e) N-terminal glycine linkers;

(f) $(G)_kC(G)_n$ with n=0-12 and k=0-5;

(g) N-terminal glycine-serine linkers

(h) $(G)_kC(G)_m(S)_l(GGGGS)_n$ with n=0-3, k=0-5, m=0-10, l=0-2;

(i) GGC

(k) GGC-NH2

(l) C-terminal gamma 1-linker

(m) C-terminal gamma 3-linker

(n) C-terminal glycine linkers

(o) $(G)_nC(G)_k$ with n=0-12 and k=0-5;

(p) C-terminal glycine-serine linkers

(q) $(G)_m(S)_l(GGGGS)_n(G)_oC(G)_k$ with n=0-3, k=0-5, m=0-10, l=0-2, and o=0-8.

133. The composition of claim 100, wherein said self antigen is a protein selected from the group consisting of:

a) a lymphotoxin;

b) a lymphotoxin receptor;

c) RANKL;

d) VEGF;

e) VEGF-R;

f) Interleukin 5;

g) Interleukin 17;

h) Interleukin 13;

i) CCL21;

k) CXCL12;

l) SDF-1;

m) MCP-1;

n) Resistin;

o) GHRH;

p) LHRH;
q) TRH;
r) MIF;
s) Eotaxin;
t) BLC;
u) a human IgE.

134. The composition of claim 100, wherein said self antigen is a protein, a peptide or fragments thereof, selected from the group consisting of:

a) a lymphotoxin;
b) a lymphotoxin receptor;
c) RANKL;
d) VEGF;
e) VEGF-R;
f) Interleukin 5;
g) Interleukin 17;
h) Interleukin 13;
i) Angiotensin;
k) CCL21;
l) CXCL12;
m) SDF-1;
n) MCP-1;
o) Endoglin;
p) Resistin;
q) GHRH;
r) LHRH;
s) TRH;
t) MIF;
u) Eotaxin;
v) Bradykinin;
w) BLC;
x) Tumor Necrosis Factor α (TNFα);
y) amyloid beta peptide ($A\beta_{1-42}$); and
z) a human IgE.

135. A composition comprising:

(a) a non-natural molecular scaffold comprising:
(i) a core particle selected from the group consisting of:
(1) a core particle of non-natural origin; and

(2) a core particle of natural origin; and

(ii) an organizer comprising at least one first attachment site, wherein said organizer is connected to said core particle by at least one covalent bond, and wherein said core particle is a virus-like particle comprising recombinant proteins, or fragments thereof, of a bacteriophage;

(b) an antigen or antigenic determinant with at least one second attachment site, said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

136. The composition of claim 135, wherein said association is by way of at least one covalent bond.

137. The composition of claim 136, wherein said one covalent bond is a non-peptide bond.

138. The composition of claim 135 wherein said core particle is selected from the group consisting of:

i) a virus;

ii) a virus-like particle;

iii) a bacteriophage;

iv) a bacterial pilus;

v) a viral capsid particle; and

vi) a recombinant form of (i), (ii), (iii), (iv) or (v).

139. The composition of claim 135, wherein said core particle is selected from the group consisting of:

i) a virus-like particle;

ii) a bacterial pilus; and

iii) a virus-like particle of a RNA-phage.

140. The composition of claim 139, wherein said virus-like particle comprising recombinant proteins, or fragments thereof, being selected from the group consisting of:

(a) recombinant proteins of Hepatitis B virus;
(b) recombinant proteins of measles virus;
(c) recombinant proteins of Sindbis virus;
(d) recombinant proteins of Rotavirus;
(e) recombinant proteins of Foot-and-Mouth-Disease virus;
(f) recombinant proteins of Retrovirus;
(g) recombinant proteins of Norwalk virus;
(h) recombinant proteins of Alphavirus;
(i) recombinant proteins of human Papilloma virus;
(j) recombinant proteins of Polyoma virus;
(k) recombinant proteins of bacteriophages; and
(l) recombinant proteins of RNA-phages;
(m) recombinant proteins of Qß-phage;
(n) recombinant proteins of GA-phage
(o) recombinant proteins of fr-phage; and
(p) recombinant proteins of Ty.

141. The composition of claim 139, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage.

142. The composition of claim 139, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of a RNA-phage being selected from the group consisting of:

a) bacteriophage Qβ;
b) bacteriophage R17;
c) bacteriophage fr;
d) bacteriophage GA;
e) bacteriophage SP;
f) bacteriophage MS2;
g) bacteriophage M11;
h) bacteriophage MX1;
i) bacteriophage NL95;
k) bacteriophage f2; and
l) bacteriophage PP7.

143. The composition of claim 139, wherein said virus-like particle comprising, or alternatively essentially consisting of, recombinant proteins, or fragments thereof, of bacteriophage Qβ or bacteriophage fr.

144. The composition of claim 135, wherein said first and/or said second attachment sites comprise:

(k) an antigen and an antibody or antibody fragment thereto;

(l) biotin and avidin;

(m) strepavidin and biotin;

(n) a receptor and its ligand;

(o) a ligand-binding protein and its ligand;

(p) interacting leucine zipper polypeptides;

(q) an amino group and a chemical group reactive thereto;

(r) a carboxyl group and a chemical group reactive thereto;

(s) a sulfhydryl group and a chemical group reactive thereto; or

(t) a combination thereof.

145. The composition of claim 135, wherein said first attachment site is an amino group and said second attachment site is a sulfhydryl group.

146. The composition of claim 135, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

147. The composition of claim 135, wherein said second attachment site does not naturally occur within said antigen or antigenic determinant.

148. The composition of claim 147, wherein said first attachment site is an amino group and said second attachment site is a sulfhydryl group.

149. The composition of claim 147, wherein said first attachment site is a lysine residue and said second attachment site is a cysteine residue.

150. The composition of claim 147, wherein said second attachment site comprises or is a sulfhydryl group or a cysteine residue.

151. The composition of claim 147, wherein said composition comprises an amino acid linker.

152. The composition of claim 150, wherein said amino acid linker is bound to said antigen or said antigenic determinant by way of at least one covalent bond.

152. The composition of 151, wherein said amino acid linker comprises, or alternatively consists of, said second attachment site.

153. The composition of claim 152, wherein said amino acid linker comprises a sulfhydryl group or a cysteine residue.

154. The composition of claim 152, wherein said amino acid linker is selected from the group consisting of:

(a) CGG;

(b) N-terminal gamma 1-linker;

(c) N-terminal gamma 3-linker;

(d) Ig hinge regions;

(e) N-terminal glycine linkers;

(f) $(G)_kC(G)_n$ with n=0-12 and k=0-5;

(g) N-terminal glycine-serine linkers;

(h) $(G)_kC(G)_m(S)_l(GGGGS)_n$ with n=0-3, k=0-5, m=0-10, l=0-2;

(i) GGC;

(k) GGC-NH2;

(l) C-terminal gamma 1-linker;

(m) C-terminal gamma 3-linker;

(n) C-terminal glycine linkers;

(o) $(G)_nC(G)_k$ with n=0-12 and k=0-5;

(p) C-terminal glycine-serine linkers;

(q) $(G)_m(S)_l(GGGGS)_n(G)_oC(G)_k$ with n=0-3, k=0-5, m=0-10, l=0-2, and o=0-8.

155. The composition of claim 135, wherein said antigen is a protein or a fragment thereof, being selected from the group consisting of:

(a) proteins suited to induce an immune response against cancer cells,

(b) proteins suited to induce an immune response against infectious diseases,

(c) proteins suited to induce an immune response against allergens, and

(d) proteins suited to induce an immune response in farm animals or pets.

156. The composition of claim 155, wherein said antigen is:

(a) a recombinant protein of HIV,

(b) a recombinant protein of Influenza virus,

(c) a recombinant protein of Hepatitis C virus,

(d) a recombinant protein of *Toxoplasma*,

(e) a recombinant protein of *Plasmodium falciparum*,

(f) a recombinant protein of *Plasmodium vivax*,

(g) a recombinant protein of *Plasmodium ovale*,

(h) a recombinant protein of *Plasmodium malariae*,

(i) a recombinant protein of breast cancer cells,

(j) a recombinant protein of kidney cancer cells,

(k) a recombinant protein of prostate cancer cells,

(l) a recombinant protein of skin cancer cells,

(m) a recombinant protein of brain cancer cells,

(n) a recombinant protein of leukemia cells,

(o) a recombinant profiling,

(p) a recombinant protein of bee sting allergy,

(q) a recombinant protein of nut allergy,

(r) a recombinant protein of food allergies,

(s) a recombinant protein of asthma, or

(t) a recombinant protein of *Chlamydia*.

157. The composition of claim 135, wherein said antigen or antigenic determinant is a peptide, a protein, or a fragment of a protein, selected from the group consisting of:

a) a phospholipase A_2 protein;

b) a human IgE;

c) a lymphotoxin;

d) an Influenza M2 protein; and

e) a Der p I peptide.

158. The composition of claim 157, wherein said antigen or said antigenic determinant is a Der p I peptide, or a fragment thereof.

159. The composition of claim 158, wherein said Der p I peptide with said second attachment site has an amino acid sequence selected from the group consisting of:

a) CGNQSLDLAEQELVDCASQHGCH; and

b) CQIYPPNANKIREALAQTHSA.

160. The composition of claim 157, wherein said antigen or said antigenic determinant is a phospholipase A_2 protein, or a fragment thereof.

161. The composition of claim 160, wherein said phospholipase A_2 protein has an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:168;

b) the amino acid sequence of SEQ ID NO:169;

c) the amino acid sequence of SEQ ID NO:170;

d) the amino acid sequence of SEQ ID NO:171;

e) the amino acid sequence of SEQ ID NO:172;

f) the amino acid sequence of SEQ ID NO:173;

g) the amino acid sequence of SEQ ID NO:174; and

h) the amino acid sequence of SEQ ID NO:175.

162. The composition of claim 157, wherein said antigen or said antigenic determinant is a human IgE, or a fragment thereof.

163. The composition of claim 162, wherein the human IgE has the amino acid sequence of SEQ ID NO:176.

164. The composition of claim 163, wherein said antigen or said antigenic determinant is an influenza M2 protein, or a fragment thereof.

165. A composition comprising an influenza M2 protein, or a fragment thereof, that has been attached by a covalent bond to a protein selected from the group consisting of a bacteriophage coat protein, a bacterial pilus, HbcAg, and fragments thereof.

166. The composition of claim 165, wherein said protein is a bacteriophage coat protein or fragment thereof.

167. The composition of claim 165, wherein said protein is a bacterial pilus.

168. The composition of claim 165, wherein said protein is HBcAg, and wherein said covalent bond is not a peptide bond.

169. The composition of claim 165, wherein if said protein is a bacteriophage coat protein or fragment thereof, or a bacterial pilus or fragment thereof, and the covalent bond is a non-peptide bond.

170. The composition of claim 165, wherein if said protein is a bacteriophage coat protein or fragment thereof, or a bacterial pilus or fragment thereof, and the covalent bond is a peptide bond.

171. The composition of claim 165, wherein said bacteriophage coat protein comprises a coat protein of a bacteriophage selected from the group consisting of:

a) bacteriophage Qβ;
b) bacteriophage R17;
c) bacteriophage fr;
d) bacteriophage GA;
e) bacteriophage SP;
f) bacteriophage MS2;
g) bacteriophage M11;
h) bacteriophage MX1;
i) bacteriophage NL95;
k) bacteriophage f2; and
l) bacteriophage PP7.

172. The composition of claim 171, wherein said bacteriophage coat protein comprises bacteriophage Qβ.

173. A pharmaceutical composition comprising:

a) the composition of claim 1, 87, 100, 135, or 165; and

b) an acceptable pharmaceutical carrier.

174. A method of immunization comprising administering the composition of claim 1, 87, 100, 135, or 165 to a subject.

175. A vaccine composition comprising the composition of claim 1, 87, 100, 135, or 165.

176. The vaccine composition of claim 160 further comprising an adjuvant.

177.. A process for producing a non-naturally occurring, ordered and repetitive antigen array comprising:

a) providing a non-natural molecular scaffold comprising:

(i) a core particle selected from the group consisting of:

(1) a core particle of non-natural origin; and

(2) a core particle of natural origin; and

(ii) an organizer comprising at least one first attachment site, wherein said organizer is connected to said core particle by at least one covalent bond; and

b) providing an antigen or antigenic determinant with at least one second attachment site, wherein said antigen or antigenic determinant is a self antigen or a fragment thereof, and wherein said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

c) combining said non-natural molecular scaffold and said antigen or antigenic determinant,

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

178. The process of claim 177, wherein said organizer is a polypeptide or residue thereof; and wherein said second attachment site is a polypeptide or residue thereof.

179. The process of claim 177 or claim 178, wherein said core particle is a virus-like particle.

180. The process of claim 179, wherein said core particle is a virus-like particle a dimer or multimer of a polypeptide comprising amino acids 1-147 of SEQ ID NO:158.

181. The process of claim 179, wherein said virus-like particle is a dimer or multimer of a polypeptide comprising amino acids 1-152 of SEQ ID NO:158.

182. The process of claim 180, wherein one or more cysteine residues of said polypeptide have been either deleted or substituted with another amino acid residue.

183. The process of claim 181, wherein the cysteine residues corresponding to amino acids 48 and 107 in SEQ ID NO:134 have been either deleted or substituted with another amino acid residue.

184. The process of claim 182, wherein one or more lysine residue of said polypeptide have been either deleted or substituted with another amino acid residue.

185. The process of claim 177, wherein said association is by way of at least one covalent bond.

186. The process of claim 185, wherein said covalent bond is a non-peptide bond.

187. A process for producing a non-naturally occurring, ordered and repetitive antigen array comprising:

a) providing a non-natural molecular scaffold comprising:

(i) a core particle; and

(ii) an organizer comprising at least one first attachment site, wherein said organizer is connected to said core particle by at least one covalent bond; and wherein said core particle is a virus-like particle comprising recombinant proteins, or fragments thereof, of a bacteriophage;

b) providing an antigen or antigenic determinant with at least one second attachment site, said second attachment site being selected from the group consisting of:

(i) an attachment site not naturally occurring with said antigen or antigenic determinant; and

(ii) an attachment site naturally occurring with said antigen or antigenic determinant,

wherein said second attachment site is capable of association through at least one non-peptide bond to said first attachment site; and

c) combining said non-natural molecular scaffold and said antigen or antigenic determinant,

wherein said antigen or antigenic determinant and said scaffold interact through said association to form an ordered and repetitive antigen array.

188. The composition of claim 187, wherein said association is by way of at least one covalent bond.

189. The composition of claim 188, wherein said covalent bond is a non-peptide bond.

190. A coat protein capable of forming a capsid which comprises mutant Qβ coat proteins having an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:255;

b) the amino acid sequence of SEQ ID NO:256;

c) the amino acid sequence of SEQ ID NO:257;

d) the amino acid sequence of SEQ ID NO:258; and

e) the amino acid sequence of SEQ ID NO:259.

191. The coat protein of claim 190, wherein at least one antigen or antigenic determinant is bound thereto.

192. A coat protein capable of forming a capsid which essentially consisting of mutant Qβ coat proteins having an amino acid sequence selected from the group consisting of:

a) the amino acid sequence of SEQ ID NO:255;
b) the amino acid sequence of SEQ ID NO:256;
c) the amino acid sequence of SEQ ID NO:257;
d) the amino acid sequence of SEQ ID NO:258;
e) the amino acid sequence of SEQ ID NO:259; and
f) a mixture of either a)-e) and the corresponding A1 protein.

193. The coat protein of claim 192, wherein at least one antigen or antigenic determinant is bound thereto.

194. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of a lymphotoxin.

195. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of a lymphotoxin receptor.

196. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of RANKL.

197. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of VEGF.

198. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of VEGF-R.

199. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Interleukin 5.

200. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Interleukin 17.

201. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Interleukin 13.

202. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment Angiotensin.

203. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of CCL21.

204. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of CXCL12.

205. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of SDF-1.

206. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of MCP-1.

207. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Endoglin.

208. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Resistin.

209 The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of GHRH.

210. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of LHRH.

211. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of TRH.

212. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of MIF.

213. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Eotaxin.

214. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Bradykinin

215. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of BLC.

216. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of Tumor Necrosis Factor α (TNFα).

217. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of amyloid beta peptide ($Aß_{1-42}$).

218. The composition of claim 1 or 100, wherein said self antigen is a protein, a peptide or a fragment of a human IgE.